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Corrosion control in ferrocement

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Since the steel component used in ferrocement on a specific surface area is greater compared to conventional concrete and cover thickness is quite small, it is necessary to look into the corrosion resistance properties of ferrocement. In this paper it is shown that the tolerable limit for chloride is less than 0.5% by weight of cement and addition of an inhibitor admixture was found to give efficient corrosion protection at all chloride concentrations ranging from 0.5 to 3%.

Key words: Ferrocement, chloride corrosion, inhibitor efficiency, impedance studies

INTRODUCTION

Ferrocement construction is largely used in low cost housing, food storage silos, irrigation troughs, water tanks, manhole covers, domes and fishing boats. The usual cover thickness provided is of the order of 2-3 mm [1]. Hence the corrosion protection entirely depends upon the impermeability of the mortar cover and the maintenance of the alkalinity around the mesh. Earlier studies have shown that at a cover of 3 mm a galvanised wire mesh is preferable. The use of rice husk ash admixture is also recommended to improve the resistance of the mortar [2]. It has also been reported that the use of Cu, or Zn oxide as an admixture is very effective, when sea water is used for mixing cement mortar [3]. It is well known that the maximum alkalinity likely to be obtained around the steel mesh or bar embedded in cement mortar or concrete is only of the order of 0.04 N (pH 12.5) and at this alkalinity, corrosion can take place when chloride concentration exceeds about 0.1% [4].

In this paper, the electrochemical behaviour of mild steel wire mesh in cement mortar with chloride and inhibitor addition has been studied.

EXPERIMENTAL

Polished 80 × 60 mm size mild steel wire mesh was centrally embedded in cement mortar with a clear cover of 2 mm. Ratios 1:1 and 1:2 were studied, with W/c ratio 0.4 chloride as NaCl and patented inhibitor admixture were added to the mixing water.

In distilled water, potential of the specimens were followed for a period of 60 days and impedance measurements using frequency response analyser were made at 20 days' interval.

In another set of experiments, weighed wire mesh was

TABLE-I: Steady state potential and corrosion rate in presence of chloride

% of Cl^-	1:1 cement mortar		1: 2 cement mortar	
	Steadystate potential (mV) vs SCE	Corr. rate (mmpy)	Steadystate potential (mV) vs SCE	Corr. rate (mmpy)
0	−475 ± 50	0	−415 ± 50	-
0.5	−525 ± 10	0.00085	−410 ± 75	0.0010
1.0	−425 ± 10	0.00093	−490 ± 20	0.0013
1.5	−455 ± 20	0.00094	−490 ± 55	0.0015
2.0	−520 ± 15	0.00116	−495 ± 20	0.0024
3.0	−510 ± 75	0.00174	−540 ± 25	0.0026

embedded in mortar and kept immersed in distilled water for 60 days. At the end of the period, the specimen was broken open and the corrosion was assessed by weight loss measurement.

RESULTS AND DISCUSSION

Effect of chloride addition

The chloride content in the cement mortar was varied from 0 to 3% by weight of cement. The results are given in Table I. It can be seen that the steady state potential lies in the range −400 to −540 mV vs SCE. Corrosion is found to occur even in the presence of 0.5% of Cl^-. Corrosion rate increases by a factor of 1.3 to 3 when the cement mortar 1:2 is used in place of 1:1.

Chloride + inhibitor addition

The patented inhibitor in the specified proportion was added to the mortar and the Cl^- concentration was varied from 0 to 3%. The results are given in Table II. Interestingly, it can be seen that the steady state potential is in the range of −175 to −280 mV vs SCE in the case of 1:1 mortar and −180 to −360 mV in the case of 1:2 mortar. There is considerable decrease in the corrosion rate and 100% protection is observed upto 1% Cl^- in 1:1 mortar and upto 0.5% Cl^- in 1:2 mortar. An inhibitor efficiency of 90% and above has been obtained upto 3% Cl^- concentration.

Impedance behaviour

R_T values calculated on the basis of the impedance curves are given in Table III. It is seen that R_T value in 1:2 mortar generally is lower when compared to 1:1 mortar in

TABLE-II: Steady state potential and corrosion rate in presence of chloride + inhibitor

% of Cl^-	1:1 cement mortar			1: 2 cement motor		
	Steadystate potential (mV) vs SCE	Corr. rate (mmpy)	Efficiency (%)	Steadystate potential (mV) vs SCE	Corr. rate (mmpy)	Efficiency (%)
0	−175 ± 10	0	100	−180 ± 40	0	100
0.5	−190 ± 15	0	100	−250 ± 30	0	100
1.0	−280 ± 10	0	100	−250 ± 45	0.00009	92.3
1.5	−225 ± 10	0.00008	92	−300 ± 30	0 00017	89.4
2.0	−250 ± 10	0.00010	93	−350 ± 20	0.00020	90.4
3.0	−280 ± 15	0.00019	90	−365 ± 25	0.00023	90.7

TABLE-III: R_T values in ohms obtained from impedance plots

Sl No.	Medium	1:2 Mortar Duration (days)			1:2 Mortar Duration (days)		
		20	40	60	20	40	60
1.	1% Cl^-	105	81	50	98	50	30
2.	1% Cl^- + inhibitor	158	90	86	112	70	60
3.	3% Cl^-	100	50	32	92	85	70
4.	3% Cl^- + inhibitor	113	52	30	107	70	40

the presence of 1% Cl^-. R_T values are further increased when inhibitor is added to the mortar. However, in the presence of 3% Cl^-, R_T values have no bearing on the corrosion rate or inhibitor efficiency.

CONCLUSION

(1) It is shown that the tolerable limit for chloride in ferrocement mortar is less than 0.5 % by weight of cement.
(2) A patented inhibitor admixture was found to have an efficiency of 90 - 100% at all chloride concentrations ranging from 0.5 to 3%.

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